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| APPLICATION NO. | FILING DATE | FIRST NAMED INVENTOR | ATTORNEY DOCKET NO. | CONFIRMATION NO. |
|---|-------------|----------------------|---------------------|------------------|
| 10/613,065 | 07/07/2003 | Michio Asahina | 101590.02 | 8562 |
| 25944 | 7590 | 10/25/2004 | EXAMINER | |
| OLIFF & BERRIDGE, PLC P.O. BOX 19928 ALEXANDRIA, VA 22320 | | | HOGANS, DAVID L | |
| | | | ART UNIT | PAPER NUMBER |
| | | | 2813 | |

DATE MAILED: 10/25/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

10/613,065

Applicant(s)

ASAHINA ET AL.

Examiner

David L. Hogans

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 29 September 2004.
- 2a) ☒ This action is **FINAL**. 2b) ☐ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-11 is/are pending in the application.
- 4a) Of the above claim(s) 11 is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1-10 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 07 July 2003 is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☒ All b) ☐ Some * c) ☐ None of:
- ☐ Certified copies of the priority documents have been received.
 - ☒ Certified copies of the priority documents have been received in Application No. 09/161,920.
 - ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- | | |
|--|---|
| 1) <input type="checkbox"/> Notice of References Cited (PTO-892) | 4) <input type="checkbox"/> Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948) | 5) <input type="checkbox"/> Notice of Informal Patent Application (PTO-152) |
| 3) <input type="checkbox"/> Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date _____ | 6) <input type="checkbox"/> Other: _____ |

DETAILED ACTION

This Office Action is in response to the Amendment filed on September 29, 2004.

Election/Restrictions

1. Newly submitted claim 11 is directed to an invention that is independent or distinct from the invention originally claimed for the following reasons:

Species I – appears to relate to Claim 11 (noting the inclusion of a wetting layer inside a via-hole that is thicker at the bottom of the via-hole than a thickness at the sidewalls and top portions of the via-hole)

Since applicant has received an action on the merits for the originally presented invention, this invention has been constructively elected by original presentation for prosecution on the merits. Accordingly, claim 11 is withdrawn from consideration as being directed to a non-elected invention. See 37 CFR 1.142(b) and MPEP § 821.03.

Status of Claims

Claims 1-8 were pending. Claims 9-11 are newly added. Claim 11 is withdrawn. Claims 1-10 are now pending.

Terminal Disclaimer

2. The terminal disclaimer filed on September 29, 2004, disclaiming the terminal portion of any patent granted on this application which would extend beyond the expiration date of 6,107,182 has been reviewed and is accepted. The terminal disclaimer has been recorded.

Claim Rejections - 35 USC § 112

The rejection of Claims 1-8 via 35 USC § 112, second paragraph, has been withdrawn pursuant to Applicant's Amendments submitted on September 29, 2004.

Claim Rejections - 35 USC § 103

1. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

2. Claims 1-10 are rejected under 35 U.S.C. 103(a) as being unpatentable over 6,309,971 to Geha in view of 6,002,175 to Maekawa further in view of 6,077,782 to Hsu et al.

Claim 1

Geha teaches a method of fabricating a semiconductor device having a semiconductor substrate including semiconductor elements, and multi-layered wiring regions, and at least one layer of the wiring regions above a first wiring region on the semiconductor substrate is fabricated using a process comprising: forming a via-hole in an interlayer dielectric formed above the first wiring region on a semiconductor substrate; removing gaseous components included within said interlayer dielectric; forming a wetting layer on the surface of said interlayer dielectric (noting Geha teaches forming a wetting layer on surfaces on which metal layers are to be formed); cooling the substrate to a temperature of no more than 100°C (noting that conventional wetting

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layers are deposited at temperatures in excess of 200°C and that the first aluminum deposition step may occur at 40°C) ; forming a first aluminum layer comprising one of aluminum and an alloy in which aluminum is the main component on said wetting layer at a temperature of a first degree C; forming a second aluminum layer comprising one of aluminum and an alloy in which aluminum is the main component on said first aluminum layer at a temperature of a second degree C; and wherein the first degree C is lower than the second degree C. (See Figures 2-8 and columns 6-11 lines 10-64)

Geha fails to explicitly teach forming a wetting layer on said dielectric and a degassing step via a heat treatment under reduced pressure and at the substrate temperature of 300°C to 550°C.

However, Maekawa, in column 7 lines 01-10, teaches a degassing step for removing gaseous components included within an interlayer dielectric by a heat treatment under reduced pressure and at the substrate temperature of 300°C to 550°C. Furthermore, Hsu et al., in Figure 2, teaches forming a wetting layer on said dielectric.

It would have been obvious to one of ordinary skill in the art to modify Geha by incorporating a degassing step for removing gaseous components included within an interlayer dielectric by a heat treatment under reduced pressure and at the substrate temperature of 300°C to 550°C, as taught by Maekawa, to remove water, nitrogen, hydrogen or other organic substances that may contaminate the adhesive interface with

an overlying layer. Finally, it would have been obvious to one of ordinary skill in the art to modify Geha by incorporating forming a wetting layer on said dielectric, as taught by Hsu et al., to prevent the migration of silicon atoms into the aluminum layer.

Furthermore, the specification contains no disclosure of either the critical nature of the claimed process conditions (i.e. – specific temperature or pressures of degassing) or any unexpected results arising therefrom. Where patentability is said to be based upon particular chosen limitations or upon another variable recited in a claim, the Applicant must show that the chosen limitations are critical. *In re Woodruff*, 919 F.2d 1575, 1578 (Fed. Cir. 1990)

Finally, it would have been obvious to one having ordinary skill in the art at the time the invention was made to optimize the degassing conditions, since it has been held that where the general conditions of a claim are disclosed in the prior art, discovering the optimum or workable ranges involves only routine skill in the art. *In re Aller*, 105 USPQ 233 (CCPA 1955)

Claim 2

Geha teaches a method of fabricating a semiconductor device having a semiconductor substrate including semiconductor elements, and multi-layered wiring regions, and at least one layer of a wiring regions above the first wiring region on the semiconductor substrate is fabricated using a process comprising: forming an interlayer

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dielectric formed above the first wiring region on a semiconductor substrate; removing gaseous components included within said interlayer dielectric; forming a wetting layer on the surface of said interlayer dielectric (noting Geha teaches forming a wetting layer on surfaces on which metal layers are to be formed); cooling the substrate to a temperature of no more than 100°C (noting that conventional wetting layers are deposited at temperatures in excess of 200°C and that the first aluminum deposition step may occur at 40°C); forming a first aluminum layer comprising one of aluminum and an alloy in which aluminum is the main component on said wetting layer at a temperature of a first degree C; forming a second aluminum layer comprising one of aluminum and an alloy in which aluminum is the main component on said first aluminum layer at a temperature of a second degree C; and wherein the first degree C is lower than the second degree C. (See Figures 2-8 and columns 6-11 lines 10-64)

Geha fails to explicitly teach forming a wetting layer on said dielectric and a degassing step via a heat treatment under reduced pressure and at the substrate temperature of 300°C to 550°C.

However, Maekawa, in column 7 lines 01-10, teaches a degassing step for removing gaseous components included within an interlayer dielectric by a heat treatment under reduced pressure and at the substrate temperature of 300°C to 550°C. Furthermore, Hsu et al., in Figure 2, teaches forming a wetting layer on said dielectric.

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It would have been obvious to one of ordinary skill in the art to modify Geha by incorporating a degassing step for removing gaseous components included within an interlayer dielectric by a heat treatment under reduced pressure and at the substrate temperature of 300°C to 550°C, as taught by Maekawa, to remove water, nitrogen, hydrogen or other organic substances that may contaminate the adhesive interface with an overlying layer. Finally, it would have been obvious to one of ordinary skill in the art to modify Geha by incorporating forming a wetting layer on said dielectric, as taught by Hsu et al., to prevent the migration of silicon atoms into the aluminum layer.

Furthermore, the specification contains no disclosure of either the critical nature of the claimed process conditions (i.e. – specific temperature or pressures of degassing) or any unexpected results arising therefrom. Where patentability is said to be based upon particular chosen limitations or upon another variable recited in a claim, the Applicant must show that the chosen limitations are critical. *In re Woodruff*, 919 F.2d 1575, 1578 (Fed. Cir. 1990)

Finally, it would have been obvious to one having ordinary skill in the art at the time the invention was made to optimize the degassing conditions, since it has been held that where the general conditions of a claim are disclosed in the prior art, discovering the optimum or workable ranges involves only routine skill in the art. *In re Aller*, 105 USPQ 233 (CCPA 1955)

Claim 3

Incorporating all arguments of Claim 1 and noting that Geha teaches wherein the first degree C is no more than 200°C and the second degree C is at least 300°C. (See Figures 2-8 and columns 6-11 lines 10-64)

Claim 4

Incorporating all arguments of Claim 2 and noting that Geha teaches wherein the first degree C is no more than 200°C and the second degree C is at least 300°C. (See Figures 2-8 and columns 6-11 lines 10-64)

Claim 5

Incorporating all arguments of Claim 1 and noting that Geha teaches wherein forming the aluminum layers is provided by sputtering. (See Figures 2-8 and columns 6-11 lines 10-64)

Claim 6

Incorporating all arguments of Claims 1 and 3 and noting that Geha teaches wherein forming the aluminum layers is provided in the same chamber and in a consecutive manner. (See Figures 2-8 and columns 6-11 lines 10-64)

Claim 7

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Incorporating all arguments of Claims 1 and 3 and noting that Geha and Maekawa fail to explicitly teach wherein cooling the substrate, forming the first aluminum layer, and forming the second aluminum layer, are performed consecutively in the same equipment having a plurality of chambers each maintained under a reduced pressure.

However, Hsu et al., in Figures 1-3 and column 4 lines 17-38, teaches cooling the substrate, forming the first aluminum layer, and forming the second aluminum layer, are performed consecutively in the same equipment having a plurality of chambers each maintained under a reduced pressure.

It would have been obvious to one of ordinary skill in the art to modify Geha and Maekawa by incorporating wherein steps (d), (e) and (f) are performed consecutively in the same equipment having a plurality of chambers each maintained under a reduced pressure, as taught by Hsu et al., to process the device in a cluster load lock tool wherein the vacuum integrity is maintained throughout the entire fabrication process to prevent reoxidation of surfaces.

Claim 8

Incorporating all arguments of Claims 1 and 3 and noting that Geha teaches wherein forming the aluminum layers is provided by controlling the temperature of the

stage (106) on which said semiconductor substrate (101) is to be mounted. (See Figures 1-8 and columns 4-11 lines 60-64)

Claim 9

Incorporating all arguments of Claim 1 and noting that Geha teaches prior to cooling the substrate, performing a heat treatment to the substrate (i.e. – heat treatments can occur during degassing and/or forming the wetting layer). (See Figures 2-8 and columns 6-11 lines 10-64)

Claim 10

Incorporating all arguments of Claim 2 and noting that Geha teaches prior to cooling the substrate, performing a heat treatment to the substrate (i.e. – heat treatments can occur during degassing and/or forming the wetting layer). (See Figures 2-8 and columns 6-11 lines 10-64)

Response to Arguments

3. Applicant's arguments filed September 29, 2004, have been fully considered but they are not persuasive.

The Applicant's proffer four main arguments, which are as follows: 1) ordered process to claimed steps; 2) Maekawa fails to teach additional elements of Claims 1 and 2; 3) Hsu fails to teach additional elements of Claims 1 and 2; and 4) no applied reference teaches cooling the substrate to a temperature of no more than 100 oC

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formed after the step of forming a wetting layer. The arguments will be addressed in order.

With regard to Applicant's first argument, Applicant's representative provided the following supporting language: "Although Maekawa discloses a degassing, as alleged in the Office Action, degassing (removing gaseous components) is not performed as recited in the rejected claims. For example, degassing in Maekawa is done after the first conductive layer is deposited and before the second conductive layer is deposited. In contrast, removal of the gaseous components in the rejected claims is performed prior to either of forming the first aluminum layer on the wetting layer or forming the second aluminum layer on the first aluminum layer. Thus, Maekawa does not contemplate the process as recited in the claims." The Examiner kindly refers Applicant's representative to MPEP § 2111 and 2111.03 which, respectively, teaches to afford a claim its broadest reasonable interpretation and that claim language such as "comprising" is open-ended. As such, the present language of Claim 1 affords Applicant no right as to ordered process steps.

With regard to Applicant's second argument, Applicant's representative provided the following supporting language: "Furthermore, in Maekawa, the second electrically conductive layer is deposited over the barrier layer. In contrast, in the rejected claims, the second metal layer is formed on the first metal layer." The Examiner merely notes that Maekawa was not cited for the construct quoted above. Maekawa was cited for the

degassing of a dielectric layer under specific pressure and temperature conditions that meet Applicant's claimed limitations. Geha already taught the premise of forming the second metal layer on the first metal layer and, as such, Maekawa need not.

With regard to Applicant's third argument, Applicant's representative provided the following supporting language: "Although Hsu discloses wetting, i.e., Ti/TiN deposition at Fig. 2C, Hsu does not disclose or suggest forming a second layer comprising one of aluminum and an aluminum alloy on the first aluminum layer, as recited in the claims." The Examiner merely notes that Hsu was not cited for forming a second layer comprising one of aluminum and an aluminum alloy on the first aluminum layer. Hsu was cited for forming a wetting layer on a dielectric. Geha already taught the premise of forming a second layer comprising one of aluminum and an aluminum alloy on the first aluminum layer and, as such, Hsu need not.

With regard to Applicant's fourth and final argument, Applicant's representative provided the following supporting language: "Furthermore, none of the applied references whether considered alone or in combination disclose cooling the substrate to a temperature of no more than 100 °C formed after the step of forming a wetting layer on a surface of the interlayer dielectric. For example, Geha fails to disclose the relationship of the temperature control between forming a wetting layer and forming a first aluminum layer. Furthermore, neither Maekawa or Hsu disclose or suggest such a relationship." In response to applicant's argument cited above, the fact that applicant

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has recognized another advantage which would flow naturally from following the suggestion of the prior art cannot be the basis for patentability when the differences would otherwise be obvious. See *Ex parte Obiaya*, 227 USPQ 58, 60 (Bd. Pat. App. & Inter. 1985). Furthermore, Applicant's claim language merely claims "cooling the substrate to a temperature of no more than 100 °C" and makes no mention of this step being subsequent to the wetting layer formation step. Since Geha teaches depositing the first aluminum layer at 40 °C, the substrate would have to have been cooled down from the deposition temperatures used in conventional wetting layer formation. For instance, Hsu teaches forming a wetting layer at 200-350 °C. Finally, the ancillary beneficial effects that Applicant's claim as distinguishing (i.e. – minimizing the amount of gases emitted from the interlayer dielectric due to a lowered processing temperature during the first aluminum layer formation phase) would have naturally occurred within Geha's process because Geha employs a deposition temperature of 40 °C for the first aluminum layer.

Conclusion

4. **THIS ACTION IS MADE FINAL.** Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire **THREE MONTHS** from the mailing date of this action. In the event a first reply is filed within **TWO MONTHS** of the mailing date of this final action and the advisory action is not mailed until after the end of the **THREE-MONTH** shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any

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extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to David L. Hogans whose telephone number is (571) 272-1691. The examiner can normally be reached on M-F (7:30-4:30).

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Carl Whitehead Jr. can be reached on (571) 272-1702. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

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